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Research Article
Parasites of Wild and Captive African Civets (*Civettictis civetta*) from Limmu, Southwestern Ethiopia

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Abstract
Background and Objective: Keeping civets in farm and extracting musk for cultural and commercial purposes is a long practice in Ethiopian traditional societies. Regardless of this, there is no information on the health related issues, both for the captive and wild civets. This study identified civet's intestinal, blood and external parasites from different groups of African civets and proposed veterinary procedures that will solve major problems among civet farmers in the country. **Materials and Methods:** Health surveillance of captive and wild African civets was conducted during 2011-2013 in Limmu-Seka, Southwestern Ethiopia. Chemical immobilization was done to collect fecal, blood and ecto-parasite samples from the two groups of civets. Standard procedures including simple and direct saline smears, floatation and sedimentation techniques for fecal analysis and thin and thick smears for blood analysis were implemented. Fluorescent Antibody Test (FAT) was carried out to test for rabies. Arthropod ecto-parasites were manually picked from immobilized civets. Parasitic richness, prevalence, load and intensity were computed and Chi-square test was used to test whether the differences among these parameters were significant for different categories of civets or not. **Results:** Six helminthes gastro-intestinal (GI) parasites, four nematodes (*Toxocara* sp., *Strongyloides* sp., *Trichuris* sp. and *Ancylostoma* sp.), two cestodes (*Dipylidium caninum* and Taeniid worms) and two blood parasites (*Babesia canis* and *Dirofilaria immitis*) were detected. In addition, five arthropod ecto-parasites including three ticks (*Amblyomma hebraeum*, *Rhipicephalus* sp. and *Hyalomma trancatum*) and two flea (*Ctenocephalides* sp. and *Spilopsyllus cuniculi*) species were identified. Tests for rabies were negative. **Conclusion:** The gastro-intestinal, blood and arthropod ecto-parasites recorded for civets during this study are common among domestic and wild canids and felids. Hence, medical procedures for domestic carnivores were effective in treating African civets.

Key words: African civets, blood parasites, captive civets, ecto-parasites, zoonotic potential

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The African civet, *Civettictis civetta* is the largest member of 'true civets' (subfamily Viverrinae) that include the Asian species; the Malabar civet (*Viverra civettina*), the large-spotted civet (*Viverra megaspila*), Malay civet (*Viverra tangalunga*), the large Indian civet (*Viverra zibetha*) and the small Indian civet (*Viverricula indica*). They possess specialized perineal glands, secretions of which serve for olfactory communication[1].

Musk from civets is widely used animal product among natives in civet ranges countries for medicinal, cultural, religious, spiritual and economic purposes[2-4]. Maintaining civets in captivity and extracting musk has been a long tradition in Ethiopia, India, China, Thailand, Kenya and Tanzania[3-5]. Except Ethiopian, most of the countries used the product for domestic consumption[5,6]. Commercially, civet musk used as a fixative in world class perfumeries[2,6].

Civet farming originates in Ethiopia and with over 90% market share; the country remains sole musk supplier for perfume industries[6,7]. Official reports show that at present over 600 licensed civet farmers maintained tens of thousands of civets in farm for commercial musk production[7,8]. Most of the farms are located in the three Southwestern zones of Ethiopia (Jimma, Illu-Abbabora and Wollega)[8].

In Ethiopia, breeding civets in captivity is not practiced. Farmers selectively trap adult male civets from the wild and keep in captivity to extract musk[9]. In general, civet farming practices in Ethiopia lacks modernization. All components of farming practices (including trapping, housing, feeding, musk extraction, etc.) show no change for over a century[10]. Besides these, no veterinary procedure is established for civets in the farm[11]. Information on health related problems such as the diversity and prevalence of internal blood and external parasites of captive civets are lacking[12].

Reports suggest that all species of the family Viverridae are susceptible to parasites of domestic and wild canids and felids[13]. They are reported to harbor the Severe Acute Respiratory Syndrome (SARS)[14]. Viverrids, in general, are among the carnivores serving as definitive or maintenance host for the deadly rabies viruses[15]. Regardless of the cultural and economic significance of civets, there were no studies on their health related problems and the husbandry lacks veterinary procedures. Regardless of the cultural and economic significance of civets, there were no studies on their health related problems and the husbandry lacks veterinary procedures. Therefore, the purpose of this study was to identify gastro-intestinal, blood and eco-parasites of wild and captive civets in the area. The findings also serve as a base for the establishment of medical procedures that were not known for the species.

MATERIALS AND METHODS

Study area: This study was conducted in Limmu Seka district, Southwestern Ethiopia. The district is located between 89°00'-98°00'N latitude and 24°00'-30°00'E longitude and covers an area of 1777 km^2. The altitude of the study area ranges between 1338-2200 m asl and receives over 1550 mm annual rainfall[11]. The district has moderately warm climate with a mean minimum and maximum annual temperature of 13.6 and 26.9°C, respectively[16]. Vegetation of the area is dominated by moist Afro montane forest, the first layer and the second layer is entirely covered by coffee plant[17].

In Ethiopia, African civet exists in altitude ranging from 500-4000 m asl, but quite abundant in the montane forest vegetation of the South and South Western part of the country[18]. At present, most of the civet farming communities in Ethiopia are confined in the three Southwestern zone (Jimma, Ilu-Ababor and Wollega) of Oromiya National Regional State, South-western Ethiopia, the majority of which are in Limmu-Seka and the surrounding districts[7,8]. The district was purposefully selected for this study because it is historically known in hosting civet farmers, for the presence of several active civet farms and for the presence of volunteer farmers to permit free access to their farm for health related data collection. Of the 28 farmers association (FA) in the district, six were randomly selected for civet trapping. Atinago town, capital of the district, was selected to establish field research center to maintain civet for health related and civet captive management research.

Methods: Written permission was secured both from the Federal Wildlife Conservation Authority (FWCA) and the Oromiya Regional Forest and Wildlife Authority (OFWA) for trapping, transporting and maintaining civets for health related, feeding and home management research. Seventeen civets were captured using different traps: net (two), padded local snares (11) and wire cage traps (four). For health related data collection, civets were immobilized by intramuscular injection using a mixture of two chemicals [Ketamine (5 mg kg^{-1}) and Diazepam (0.5 mg kg^{-1})][19,13].

Fecal analysis: To study the diversity, prevalence and load of gastro-intestinal parasites of civets, fecal samples were collected from the 17 newly trapped civets. During the quarantine period, the newly recruited civet was immobilized and rectal fecal samples were independently collected[13]. To remove worms, after data collection, civets were given anti-helminthes (Canine Albendazole, 300 mg/day) for three days. Few days after the treatment, scat sample was collected from each civet for confirmatory test.

Simple and direct saline smear procedures were implemented for qualitative parasitic detection[20]. Fecal floatation (using Sheather's sucrose solution media)[21] and fecal sedimentation techniques[13] were implemented to concentrate relatively lighter and heavier eggs and larvae or cysts in fecal samples, respectively. When necessary, Giemsa stain was used and specimens were examined under the microscope. Morphological characters of eggs and larvae[22] were used to identify parasitic species in samples. McMaster egg counting protocol was also implemented to count eggs of few parasites to determine the parasitic load[23].

Blood analysis: To assess the diversity of blood parasites, approximately 2 mL of blood was drawn from the cephalic vein of the immobilized civets. This was poured into evacuated blood tubes with anticoagulant (sodium citrate) solution and refrigerated until further analysis[24].

During the analysis, blood samples were thin and thick smeared, fixed in methanol, stained with Giemsa's stain and examined under a microscope[22]. Blood cell parasites were identified by the characteristic stains of the parasitic cytoplasm and the nuclear materials[22]. Microfilaria in blood was identified through isolation of long, thin, thread like and highly mobile worms in the blood smear and species assignment was done by using diagrammatic representation of most common worms[22].

Arthropod ecto-parasites: The diversity of arthropod ecto-parasites was assessed by collecting parasites from civet body parts. From the immobilized civets, all accessible ticks were handpicked and placed in screw capped glass with 70% ethanol[25]. The hair of each civet was combed onto a moistened plastic sheet (2×2 m) beneath the immobilized civet. Fleas from each civet were collected and kept separately in 70% ethanol[26]. In order to ease the hair combing and prevent fleas from escaping, water was sprayed.

Test for rabies: Freshly decapitated five civet skulls collected during the study (between 2011 and 2013) were used to test for the reservoir potential of African civets for rabies viruses. Samples were deep frozen (-80°C) until further analysis. Tissue samples from three brain regions (hippocampus, cerebellum and medulla oblongata) were used for the analysis[27]. Fluorescent Antibody Test (FAT) procedure was implemented for diagnosis of rabies in the samples[28] and the examination was performed in the Ethiopian Health and Nutrition Research Institute (EHNRI), Addis Ababa.

Comparative data collection: Parasitic diversity and prevalence was compared between the newly recruited civets and those already maintained in traditional farms. Similar procedure was used to collect health related data from 36 civets maintained in six traditional farms (having average duration between 4 months and 6 years in captivity).

Data analysis: Parasitic richness was evaluated following the definition of Budischak *et al.*[21].The prevalence of each parasite (percent of hosts infested) and mean intensity (average number of specific parasite/host) were calculated[25]. Chi-square test was used to compare parasitic prevalence between sex, age classes and the altitude of the area from where civets were trapped (only for civets in the research center)[29]. Locally available canine medicines to treat internal (e.g., *Strongloides* sp., *Toxocara* sp.) and external parasites[30-34] with dosage for adult dogs were applied (with dosage for adult dogs) to the newly recruited civets and impacts were recorded. For this study, any p-value less than 0.05 was considered statistically significant.

RESULTS

Parasites recorded: The analysis of fecal samples revealed six (four Nematodes and two Cestodes) helminthes gastro-intestinal parasites from six families. The nematode worms were *Toxocara* sp., *Strongyloides* sp., *Trichuris* sp. and *Ancylostoma* sp. The cestodes were *Dipylidium caninum* and Taeniid eggs. The blood samples yielded a protozoa (*Babesia canis*) and nematode (*Dirofilaria immitis*) haemoparasites. The arthropod ecto-parasites from new civets include three tick species from family Ixodidae (*Amblyomma hebraeum*, *Rhipicephalus* sp. and *Hyalomma trancatum*) and two flea species (*Ctenocephalides* sp. and *Spilopsyllus cuniculi*). Except for *S. cuniculi* and *D. immitis*, all parasitic species recorded from newly trapped civets were also represented in fecal, blood and ecto-parasitic samples collected from civets in traditional farms (Table 1). For both civet groups, the fecal sedimentation procedure yielded no eggs of trematode worms. Results for rabies tests were all negative.

Parasitic prevalence: The prevalence of parasites recorded from civets is given in Table 2. Accordingly, the *Taxocara* sp. was most prevalent endo-parasite in both civet groups. This was followed by *Ancylostoma* sp. The two worms, Taeniid and *Trichuris* sp. were equally infested both groups (Table 2). From the two blood parasites, *Babesia canis* was relatively more prevalent, while the dog heart worm (*Dirofilaria immitis*) was detected only from a single civet. Nineteen percent of captive civets contained *Babesia canis*.

Table 1: Diversity and prevalence of parasites recorded from the African civets, South-western Ethiopia

	Number of civets infected and the prevalence		
Parasites	Family	NRC (n = 17)	TCF (n = 36)
GIT parasite			
Cestodes			
Taeniid sp.	Taeniidae	9 (53%)	8 (22.%)
Dipylidium caninum	Dipylidiidae	6 (35%)	10 (27.7%)
Nematodes			
Toxocara sp.	Toxocaridae	11 (64%)	18 (50%)
Trichuris sp.	Trichuridae	9 (53%)	14 (9%)
Ancylostoma sp.	Ancylostomatidae	6 (35%)	17 (47%)
Strongyloides sp.	Strongyloididae	8 (47%)	9 (25%)
External parasites			
Ticks			
Amblyomma hebraeum	Ixodidae	15 (88%)	8 (22%)
Rhipicephalus sp.	Ixodidae	14 (82%)	6 (17%)
Hyaloma trancatum	Ixodidae	9 (53%)	4 (11%)
Fleas			
Ctenocephalides sp.	Pulicidae	17 (100%)	32 (89%)
Spilopsyllus cuniculi	Pulicidae	5 (29%)	
Haemoparasites			
Dirofilaria immitis	Onchocercidae	1 (5.8%)	--
Babesia canis	Babesiidae	4 (24%)	7 (19%)

Table 2: Comparison of prevalence of internal and external parasites between sexes, ages and altitudes for the newly trapped African civets

	Sex		Age		Altitude	
Parasite sp.	M	F	Ad	S/a	<2000 m	> 2000 m
Internal parasites						
Echinococcus sp.	6	3	8	1	6	3
Dipylidium caninum	4	2	5	1	4	2
Toxocara sp.	7	4	8	3	8	3
Trichuris sp.	6	3	7	2	7	2
Ancylostoma sp.	4	2	5	1	6	0
Strongloides sp.	5	3	6	2	5	3
Ectoparasites						
Tick						
Amblyoma hebraeum	8	7	11	4	12	3
Rhipicephalid sp.	9	5	11	3	12	2
Hyaloma trancatum	6	3	7	2	7	2
Flea						
Ctenocephalides sp.	10	7	12	5	12	5
Spillopsyllus cuniculi	3	2	5	0	5	0
Haemoparasites						
Dirofilaria immittis	1	0	0	1	1	0
Babesia canis	2	2	4	0	3	1

M: Male (n = 10), F: Female (n = 7), Ad: Adult (n = 12), S/a: Sub-adult (n = 5), altitude <2000 m asl (n = 12), altitude >2000 m m asl (n = 5)

The differences in the prevalence of both internal and external parasites were obvious between sex, age and altitude of the localities from where new civets were trapped. Accordingly, more adult male civets from relatively lower altitude areas harbored more parasites (both internal and external) than females and sub-adult counterparts and those recruited from relatively higher altitudes (only for new civets).

Parasitic load: Among the ecto-parasites from the newly captured civets, *Rhipicephalus* was the abundant tick species with number varying between 6 and 54, average 24.3 ($\pm$16.3)/civet. This was followed by *H. trancatum* with load ranging between four and 34, average (17$\pm$9.5). The most prevalent tick species, *A. hebraeum*, had the least individuals per civet that ranged between 7 and 18, average 11 ($\pm$3.8). Unlike the newly captured civets, load and prevalence of ectoparasites were low on civets in traditional farms. Likewise, *Rhipicephalus* sp. was relatively abundant (between 9 and 21, (10$\pm$4.6)), followed by *A. hebraeum* with individuals varying between 6 and 15, (8.4$\pm$4). The least prevalent tick, *H. trancatum*, was also the least abundant (with individuals ranging between 4 and 10, (6.3$\pm$2.6).

Parasitic richness: For both groups of civets, endo-parasitic richness varied between 1-4 parasites per civet and co-infestation was a common phenomenon. Accordingly, from the 17 newly trapped civets, only two individual civets harbored single internal parasite (*Toxocara* sp. and Taeniid eggs) each with relatively high load (1120 and 950 eggs g^{-1} of feces), respectively. Two civets harbored two different gastro-intestinal parasites, nine civets contained three and four civets contained four. Similarly, out of the 36 captive civets seven of them harbored one, 18 contained two, nine civets harbored three and two civets harbored four gastro-intestinal parasites.

Two newly recruited civets harbored single species of tick (*Rhipicephalus* sp.). Nine civets harbored two tick species, of which *Rhipicephalus* sp. and *A. hebraeum* co-infested 6 civets and the remaining were infested by *A. hebraeum* and *H. trancatum.* All tick species were recorded from six newly captured civets. In civets from traditional farms, two civets harbored one tick species (*A. hebraeum*), 8 harbored two (*A. hebraeum* and *Rhipicephalus* sp. co-infested 4, *Rhipicephalus* sp. and *H. trancatum* 2 and *A. hebraeum* and *H. trancatum* 2 civets). Two flea species co-infested five newly trapped civets.

Treatments: Fleas were effectively treated by locally available insecticide spray (e.g., Roach killer). Amitraz solution (Ethiomiraz 12.5% EC) diluted in tap water (with proportion 1:20 water) were applied to eradicate ticks. Cyclone wound spray was applied to cure wounds and injuries. For different worms, many drugs with broad applications were used and found effective. For all Cestode and Nematode worms, canine Albendazole, Mebendazole or Febental were alternatively used. To treat the blood parasite, *Babesia* sp., Diminazene-aceturate with dose[35] 3.8 mg kg^{-1} was applied. Diarrheas due to unknown source or non-specific ailments were treated by different broad spectrum antibiotics such as the orally administered Biotin or intramuscular injection of Penistrip (5 mL/day for three days). Castor oil/or any vegetable oil was used to ease constipation and Niacin (0.27 mg kg^{-1}) or commercial multivitamin was used to reverse loss of appetite.

DISCUSSION

During this study, four nematode and two cestode helminthes gastro-intestinal, two blood and five arthropod ecto-parasites were comprehensively recorded from wild and captive African civets. None of these parasites, however, was unique to the African civets. Most were among those commonly reported for carnivores, mostly canids and felids. From their feral habit, habitat and feeding behavior, harboring parasites identical to domestic canids is quite expected for the African civets. Likewise, most authors agreed that members in viverridae are susceptible to canine and feline parasites[24,13].

Each civet was prevalent to at least one specie of helminth parasite commonly reported from different groups of domestic and wild carnivores[36]. *Ancylostoma* sp., is well represented in both civet groups. It is a common hookworm of domestic carnivores throughout the world[37] and from captive African civets[12]. Reports show that *Strongyloides* sp. (threadworm) parasitizes domestic and wild canids, felids, viverrids, humans and non-human primates[18]. It has high zoonotic potential and is becoming a major human health problem, infecting millions each year.

Dipylidium caninum is one of the most common tapeworms of dogs and cats worldwide[29]. This was the first record for the African civets. The parasite can readily infest any of the three intermediate hosts (fleas of the *Ctenocephalides* spp., *Pulex irritance* or dog's louse and *Trichodectes canis*)[38]. Mammals contract the parasite through ingesting the infected fleas (e.g., during grooming).

Fecal samples of 52.9% (new recruits) and 22.2% (captive civets) contained Taeniid eggs. During this study, Taeniid eggs were the second most abundant gastrointestinal parasites. They are morphologically similar and difficult to distinguish between the species[39]. Hence, during this study, all characteristic eggs were merged and assigned as Taeniid eggs. *Trichuris* sp. (whip worm) is common in the cecum and colon of domestic and wild canids[40], felids[41] and viverrids[42]. This was the first report for the African civet and the prevalence was well within the range recorded for most definitive hosts.

Of the seven *Toxocara* sp., *T. canis* and *T. cati* are the most important agents of toxocariasis[31]. During this study, it was the most prevalent parasite for both civet groups. In any positively identified hosts, the prevalence and load of *Toxocara* spp. were reported high[29]. Morphologically, eggs of all *Toxocara* sp., look similar for precise species identification[31]. Hence, eggs with the specific morphological characters were identified as *Toxocara* sp.

During this study, ecto-parasites were found the most important health problem for African civets. Almost 100% of the civets contracted at least two of the five listed for both groups of civets. Multiple infestations of different tick genera were common in carnivores, including viverrids[25]. Kocan *et al.*[43] reviewed tick-borne pathogens of veterinary importance. As some pathogens are zoonotic, ticks and the pathogens they transmit particularly relevant to the wildlife-livestock-human interface[25]. The most dominant flea species of domestic and wild carnivores are from *Ctenocephalides* spp. (*C. felis* and *C. canis*)[32]. During the present study, nearly 100% of the new and 98% of the captive civets harbored fleas of two species. From the behavioral records of African civets and with non-specific feeding of *Ctenocephalides* sp., the present finding was quite expected. *Ctenocephalide* spp., are carriers of several bacterial parasites of zoonotic importance and are intermediate hosts for larvae of *D. caninum*[33], common parasites in civets. The rabbit flea, *Spilopsyllus cuniculi*, mostly occurs in rabbits and hare and occasionally infests canids, felids and other mammals[33]. African civets may not be appropriate host for *S. cuniculi*, unlike other social animals and may probably accidentally contract it through their prey.

Ethiopia is within the range of the distribution of *D. immitis*[44], however, no published report on infestation has been accessed from domestic or wild carnivores. During this study, only three individuals of microfilaria were detected from blood sample of single sub-adult male African civet that died a month later. This was later confirmed after the dissection of heart from the dead civet. About 16 individual adult worms of *D. immitis* were collected from the base of pulmonary artery and right ventricle. All specimens were preserved in the laboratory of the College of Agriculture and Veterinary Medicine, Jimma University. The parasite was detected from dogs in Northern Kenya[45]. The record alarms the need for an extended survey of the parasite on the definitive and other susceptible carnivore hosts before it causes adverse effects.

Reports of rabies cases in hyenids, viverrids and wild felids were common[14] and African civets serve both as definitive or maintenance host[15]. During the present study, all the five skulls tested negative. Most wildlife rabies reports were associated with rabies outbreaks[46]. The present data were collected outside of such outbreaks. Informants reported that no report was recorded of rabid captive civets in the history of civet farming in Ethiopia. However, the present and past reports may not guarantee the immunity of African civets against rabies. Hence a long quarantine time and rabies vaccines are always recommended before bringing newly trapped civets captivity.

From the zoonotic point of view, some of the parasites recorded in African civets also infect humans. Husbandry in African civets is unique in that the animals are entirely dependent on humans for food, sanitation and health issues. In most traditional civet farms, these responsibilities are left for women and children who have little or no education on hygiene. In this regard, the risk of infesting zoonotic infections is much higher for civet farming families than those maintaining one or few pets. In the present study area, the number of civets per farm ranged between 4 and 8 (6, n = 6), but as high as 80 in some large farms. The risk of zoonotic infection increases with the number of civets in farm. Therefore, modernizing the farm and incorporating veterinary procedures as an important component of the farm may minimize or avoid the risks.

At present, there is no established medical procedures specific to viverrid health problems. However, health problems and medications in viverrids are all related to the domestic carnivores. During the present study, medicines and treatment procedures for domestic carnivores were adopted to treat all the observed health problems of the African civet and found effective. Hence, the veterinary medication procedures established for dogs and cats also apply to viverrids.

Ethiopia has adopted international wildlife safety standards[35] that state all institutions (zoos, aquarium and private farms) to have human and legal obligations to provide proper husbandry, veterinary medical treatment and preventive medical programs for the maintained wild animals[13]. To make these regulations effective, all governing authorities at all levels in Ethiopia should confirm the fulfillment of the stated minimum standards before issuing license for capture and utilization of the African civets.

The present study listed most common sources of health problems of newly recruited civets and those already in farms. As most of the internal and external parasites recorded for civets are also common among different wild and domestic species, keeping new civets in quarantine and thorough medical examination and treatment is recommended before mixing them to captive stock. Any contact between civets and other farm animals should be avoided. Since the identified parasites are common in domestic dogs and cats, treatment procedures established for these are also found effective for civets. However, further experiment should be conducted by vets to specify the dosage. In addition, further assessments covering wider localities are recommended to come up with comprehensive understanding of health issues of this extensively exploited natural resource.

CONCLUSION

This study revealed that nematodes (*Toxocara* sp., *Strongyloides* sp., *Trichuris* sp. and *Ancylostoma* sp.) and cestodes (*Dipylidium caninum* and Taeniid eggs) are common helminthes intestinal parasites of the African civet. From these worms, *Taxocara* sp., was most prevalent and followed by *Ancylostoma* sp. Two blood parasites, a protozoan (*Babesia canis*) and a nematode (*Dirofilaria immitis*), were also recorded, the former more prevalent. In addition, five arthropod ecto-parasites; three tick (all from Ixodidae); including *Amblyomma hebraeum, Rhipicephalus* sp. and *Hyalomma trancatum* and two flea species (*Ctenocephalides* sp. and *Spilopsyllus cuniculi*) were also recorded from civets during this study. Medical treatments recommended for domestic canids and felids found effective to treat civets.

SIGNIFICANCE STATEMENTS

This study comprehensively reports the internal blood and external parasites from wild and captive African civets. These are the major reasons for death of the animals threatening the wellbeing of civet farmers. It also identifies the remedial treatments, for each problem, which have never been recognized before. The findings are highly significant for farmers earning, their living by extracting musk from captive civets.

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REFERENCES

1. Kingdon, J., 1997. The Kingdon Field Guide to African Mammals. Academic Press, London, UK., pp: 1-273.
2. Mohan, R.S.L., 1994. Trade in civetone from the small Indian civet (*Viverricula indica*) from Malabar. Indian Small Carnivore Conserv., 10: 13-22.
3. Balakrishnan, M. and M.B. Sreedevi, 2007. Captive breeding of the small Indian civet *Viverricula indica* (E. Geoffroy Saint-Hilaire, 1803). Small Carnivore Conserv., 36: 5-8.
4. Balakrishnan, M. and M.B. Sreedevi, 2007. Husbandry and management of the Small Indian civet *Viverricula indica* (E. Geoffroy Saint-Hilaire, 1803) in Kerala, India. Small Carnivore Conserv., 36: 9-13.
5. Fletchall, N.B., M. Rodden and S. Taylor, 1995. Husbandry Manual for the Maned Wolf *Chrysocyon brachyurus*. John Ball Zoo, USA., pp: 1-76.
6. Abebe, Y.D., 2003. Sustainable utilization of the African civet (*Civettictis civetta*) in Ethiopia. Proceedings of the 2nd Pan-African Symposium on the Sustainable use of Natural Resources in Africa, (PASSNRA'03), Gland, Switzerland, pp: 1-18.
7. Wakjira, K., 2005. Improving civet cat farming for quality musk production (Amharic version). Agric. Res. Dev. Bull., 2: 31-34.
8. OFWA., 2013. Small scale civet farms in Oromiya. Oromiya Forest and Wildlife Authority (OFWA), Field Report, Addis Ababa, pp: 1-16.
9. EWCO., 1999. General information on Oromia wildlife resources. Ethiopian Wildlife Conservation Organization (EWCO), Addis Ababa, pp: 32.
10. WSPA., 2000. Civet farming: An Ethiopian investigation. World Society for the Protection of Animals (WSPA), London, pp: 29.
11. Hillman, J.C., 1987. Civet utilisation and research. A Report to the Ethiopian Wildlife Conservation Organization (EWCO), Addis Ababa, Ethiopia, pp: 33.
12. Tolosa, T. and F. Regassa, 2007. The husbandry, welfare and health of captive African civets (*Vivera civetica*) in Western Ethiopia. Anim. Welfare, 16: 15-19.
13. AZA., 2010. Viverrids (*Viverridae*) care manual. Association of Zoos and Aquariums, Silver Spring, MD., USA., pp: 1-107.
14. Guan, Y., B.J. Zheng, Y.Q. He, X.L. Liu and Z.X. Zhuang *et al*., 2003. Isolation and characterization of viruses related to the SARS coronavirus from animals in southern China. Science, 302: 275-278.
15. Lembo, T., K. Hampson, D.T. Haydon, M. Craft and A. Dobson *et al*., 2008. Exploring reservoir dynamics: A case study of rabies in the Serengeti ecosystem. J. Applied Ecol., 45: 1246-1257.
16. ENMA., 2012. Ten years rainfall and temperature data from 2001-2011. Report, Ethiopian National Meteorological Agency, Jimma Sub-Branch Office, Jimma, Ethiopia, pp: 38.
17. Demissew, S., P. Cribb and F. Rasmussen, 2004. Field Guide to Ethiopian Orchids. Royal Botanic Gardens, Kew, UK., ISBN-13: 9781842460719, pp: 235.
18. Yalden, D.W., M.J. Largen and D. Kock, 1980. Catalogue of the mammals of Ethiopia: 4. Carnivora. Monit. Zool. Ital. Suppl., 13: 169-272.
19. Admasu, E., S.J. Thirgood, A. Bekele and M.K. Laurenson, 2004. A note on the spatial ecology of African civet *Civettictis civetta* and common genet *Genetta genetta* in farmland in the Ethiopian Highlands. Afr. J. Ecol., 42: 160-162.
20. Woodford, M.H., 2000. Quarantine and health screening protocols for wildlife prior to translocation and release into the wild. IUCN Species Survival Commission's Veterinary Specialist Group, Gland, Switzerland, December 2000, pp: 87.
21. Budischak, S.A., A.E. Jolles and V.O. Ezenwa, 2012. Direct and indirect costs of co-infection in the wild: Linking gastrointestinal parasite communities, host hematology and immune function. Int. J. Parasitol.: Parasit. Wildlife, 1: 2-12.

22. NCCLS., 2000. Laboratory Diagnosis of Blood-borne Parasitic Diseases; Approved Guideline. The National Committee for Clinical Laboratory Standards, USA., pp: 59.
23. Elmore, S.A., L.F. Lalonde, G. Samelius, R.T. Alisauskas, A.A. Gajadhar and E.J. Jenkins, 2013. Endoparasites in the feces of arctic foxes in a terrestrial ecosystem in Canada. Int. J. Parasitol.: Parasit. Wildlife, 2: 90-96.
24. Aroon, S., T. Artchawachom, J.G. Hill, S. Kupittayanant and N. Thanee, 2009. Ectoparasites of the common palm civet (*Paradoxurus hermaphrodites*) at Sakaerat environmental research station, Thailand. Suranaree J. Sci. Tachnol., 16: 277-281.
25. Anderson, K., V.O. Ezenwa and A.E. Jolles, 2013. Tick infestation patterns in free ranging African buffalo (*Syncercus caffer*): Effects of host innate immunity and niche segregation among tick species. Int. J. Parasitol. Parasites Wildl., 2: 1-9.
26. Paterson, S., 2008. Manual of Skin Disease of the Dogs and Cats. 2nd Edn., John Willey and Sons Ltd., UK., Pages: 365.
27. Shankar, B.P., 2009. Advances in diagnosis of rabies. Vet. World, 2: 74-77.
28. WHO., 2001. Proceedings of the Southern and Eastern African Rabies group/world health organization meeting. Sixth SEARG Meeting, Lilongwe 18-21 June 2001, pp: 1-227. http://searg.info/fichiers/articles/2001L.PDF
29. Xhaxhiu, D., I. Kusi, D. Rapti, E. Kondi and R. Postoli *et al*., 2011. Principal intestinal parasites of dogs in Tirana, Albania. Parasitol. Res., 108: 341-353.
30. Yang, M., E.B. Gebeyehu, S.J. Jung, O.D. Kwon and D. Kwak, 2013. Treatment of naturally acquired *Strongyloides stercoralis* infection in a dog with ivermectin. J. Anim. Plant Sci., 23: 337-339.
31. Antolova, D., K. Reiterova, M. Miterpakova, M. Stanko and P. Dubibsky, 2004. Circulation of *Toxocara* spp. in suburban and rural ecosystems in the Slovak Republic. Vet. Parasitol., 126: 317-324.
32. Rust, M.K., 2005. Advances in the control of *Ctenocephalides felis* (cat flea) on cats and dogs. Trends Parasitol., 21: 232-236.
33. Otranto, D. and R. Wall, 2008. New strategies for the control of arthropod vectors of disease in dogs and cats. J. Med. Vet. Entom., 22: 291-302.
34. Carter, G.R., 2001. Internal Parasitic Diseases of Dogs and Cats. In: A Concise Guide to Infectious and Parasitic Diseases of Dogs and Cats, Carter, G.R. (Ed.)., International Veterinary Information Service (www.ivis.org), Ithaca, New York, pp: 15.
35. EWCA., 2013. Musk importing countries. Ethiopian Wildlife Conservation Authority, Report Addis Ababa.
36. Dybing, N.A., P.A. Fleming and P.J. Adams, 2013. Environmental conditions predict helminth prevalence in red foxes in Western Australia. Int. J. Parasitol.: Parasit. Wildlife, 2: 165-172.
37. Ngui, R., Y.A.L. Lim, R. Traub, R. Mahmud and M.S. Mistam, 2012. Epidemiological and genetic data supporting the transmission of *Ancylostoma ceylanicum* among human and domestic animals. PLoS Negl. Trop. Dis., Vol. 6. 10.1371/journal.pntd.0001522.
38. Adam, A.A., O.M. Saeed, H.M. Ibrahim, H.Y. El Malik and M.E. Ahmed, 2012. *Dipylidium caninum* infection in a 41-year-old Sudanese man in Nyala, Sudan: The first reported case in Sudan in 2006. Al Neelain Med. J., 2: 37-42.
39. Guerra, D.R.A., 2012. The sylvatic and synanthropic cycles of *Echinococcus* spp., *Taenia* spp. and *Toxocara* spp. in Portugal: Coprologic and molecular diagnosis in canids. Master Thesis, Universidade Tecnica De Lisboa, Portugal.
40. Kirkova, Z., D. Georgieva and E. Raychev, 2006. Study on the prevalence of *Trichurosis* in different categories of dogs and wild carnivores. Bulgarian J. Vet. Med., 9: 141-147.
41. Shirbhate, M.V., 2007. Quantification of predation and incidence of parasitic infestation in Melghat Tiger Reserve with special reference to Leopards (*Panthera pardus*). Bioscan, 2: 41-46.
42. Sillero-Zubiri, C., M. Hoffmann and D.W. Macdonald, 2004. Canids: Foxes, Wolves, Jackals and Dogs: Status Survey and Conservation Action Plan. IUCN-The World Conservation Union, Cambridge, UK., ISBN: 9782831707860, Pages: 430.
43. Kocan, K.M., J. de la Fuente, E.F. Blouin, J.F. Coetzee and S.A. Ewing, 2010. The natural history of *Anaplasma marginale*. Vet. Parasitol., 167: 95-107.
44. Cringoli, G., L. Rinaldi, V. Veneziano and G. Capelli, 2001. A prevalence survey and risk analysis of filariosis in dogs from the Mt. Vesuvius area of Southern Italy. Vet. Parasitol., 102: 243-252.
45. Mutasa, J.A., 1994. A survey of the prevalence of *Dirofilaria immitis* (Heartworm) infection in dogs along the Kenyan coast, M.Sc. Thesis, University of Nirobi, Kenya.
46. Kat, P.W., K.A. Alexander, J.S. Smith, J.D. Richardson and L. Munson, 1996. Rabies among African wild dogs (*Lycaon pictus*) in the Masai Mara, Kenya. J. Vet. Diagn. Invest., 8: 420-426.